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First investigations of possibilities for a through-going UCN tube at the ESS

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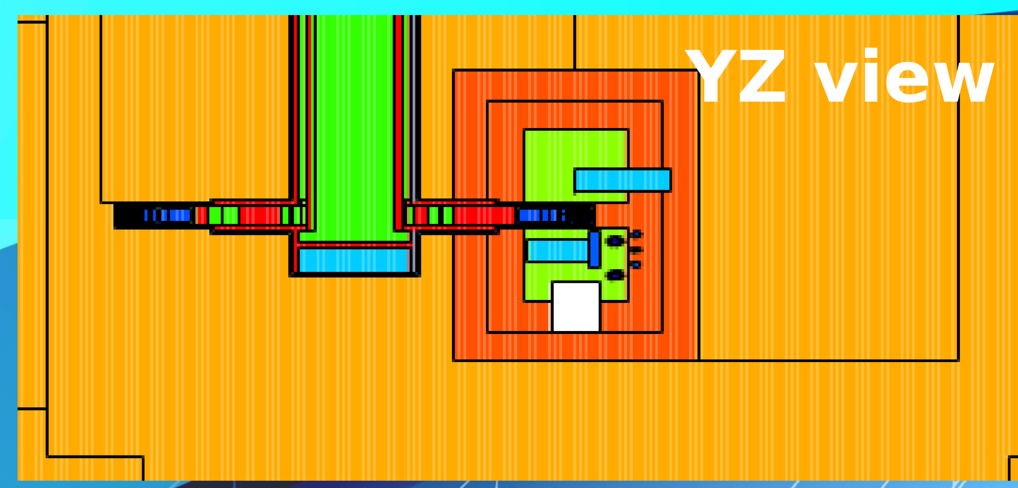
UCN @ ESS

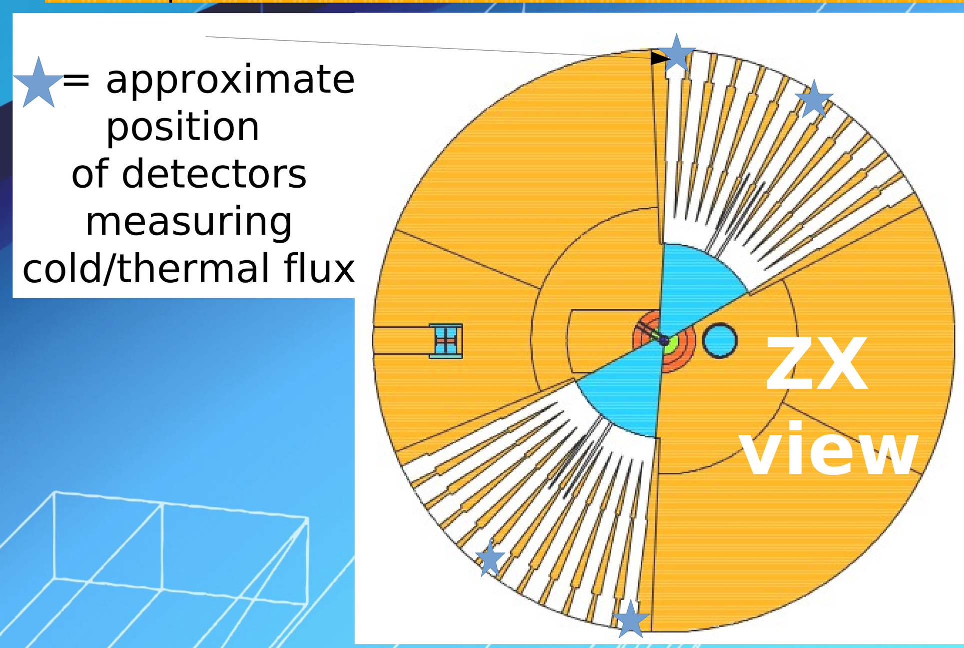
The European Spallation Source (ESS), presently starting construction in Lund, Sweden, will be the most intense source of spallation neutrons ever built[1]. Protons from a 5MW, 2.5GeV linear accelerator will impact a rotating tungsten target in 14, 2.86ms long pulses every second. The spallation neutrons hereby created are thermalized in water and some of them are further cooled in liquid para-hydrogen before extracted through individual beam-lines serving 22 cold/thermal instruments.

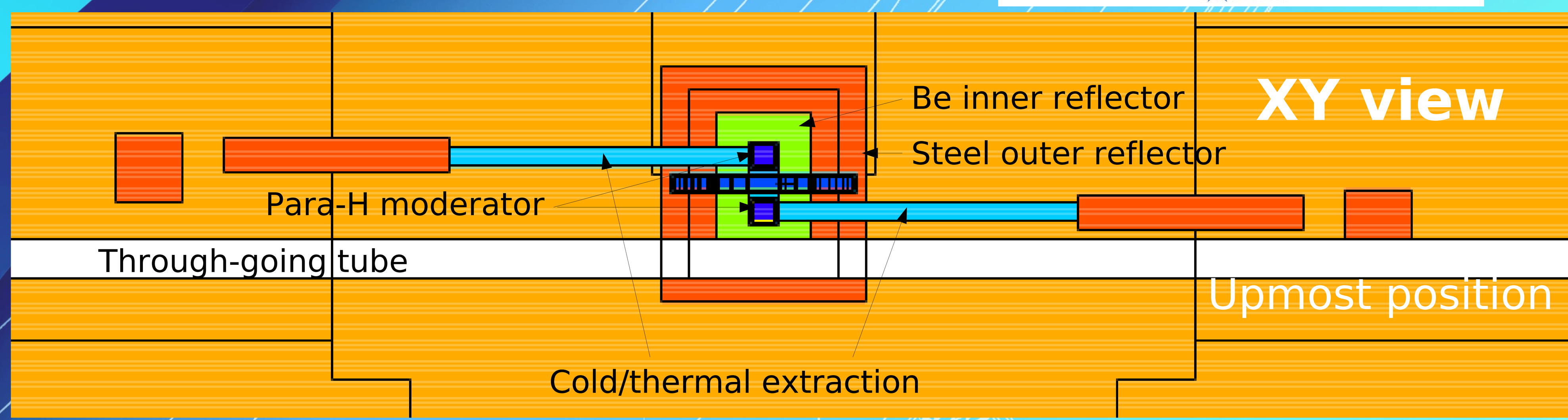
In the present study, we investigate the possibilities of installing a through-going beam-tube for in-pile ultra cold neutron (UCN) extraction at the ESS.
The study is guided by the requirement that the performance of the existing 22 cold/thermal beamlines cannot be seriously affected – i.e. the cold/thermal neutron flux at the instruments must be ~unaffected by the introduction of a tube.
Please refer to [2] for a more detailed information.

Punching a hole in the ESS Target monolith

- 25cm x 25cm through-going beamtube placed perpendicular to the proton beam)
- The beam-tube height is varied between:
  - Upmost position y=-33.5cm (central in the tube)
  - Lowest position y=-50.0cm (central in the tube)
- **Impact:** Detectors placed at the monolith boundary (beam extraction), and measure time-averaged cold+thermal flux relative to baseline design

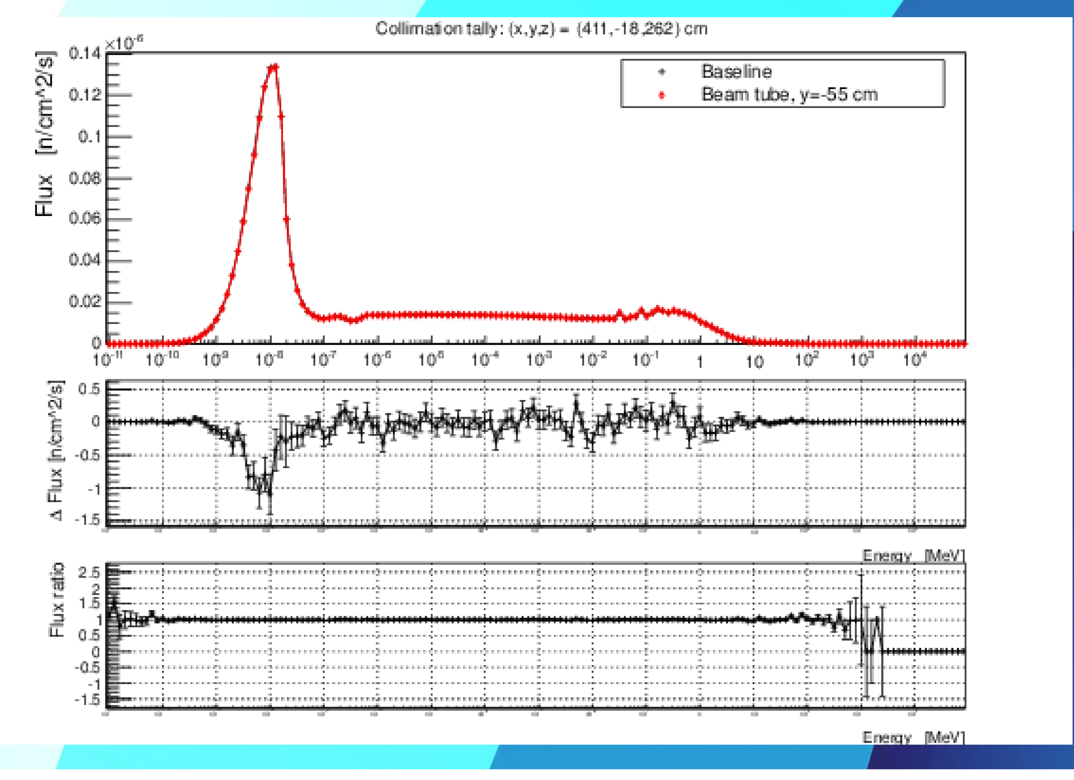




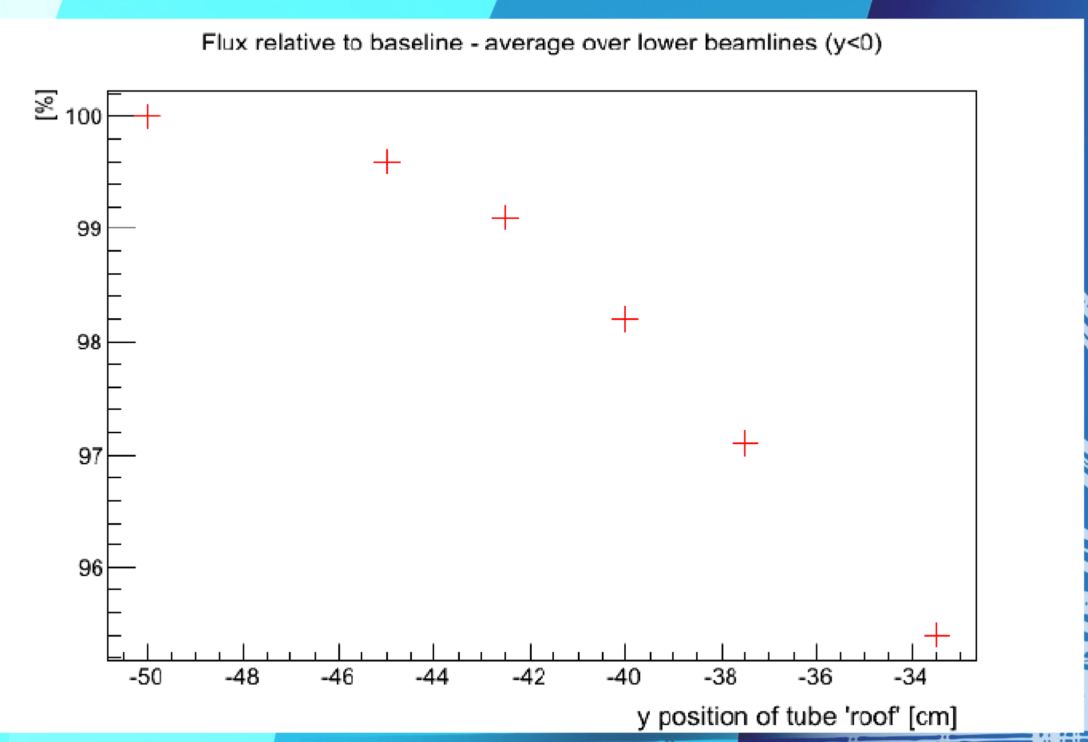


Through-going beam-tube introduced in the Baseline ESS target monolith geometry [1]

Impact on cold/thermal beamlines

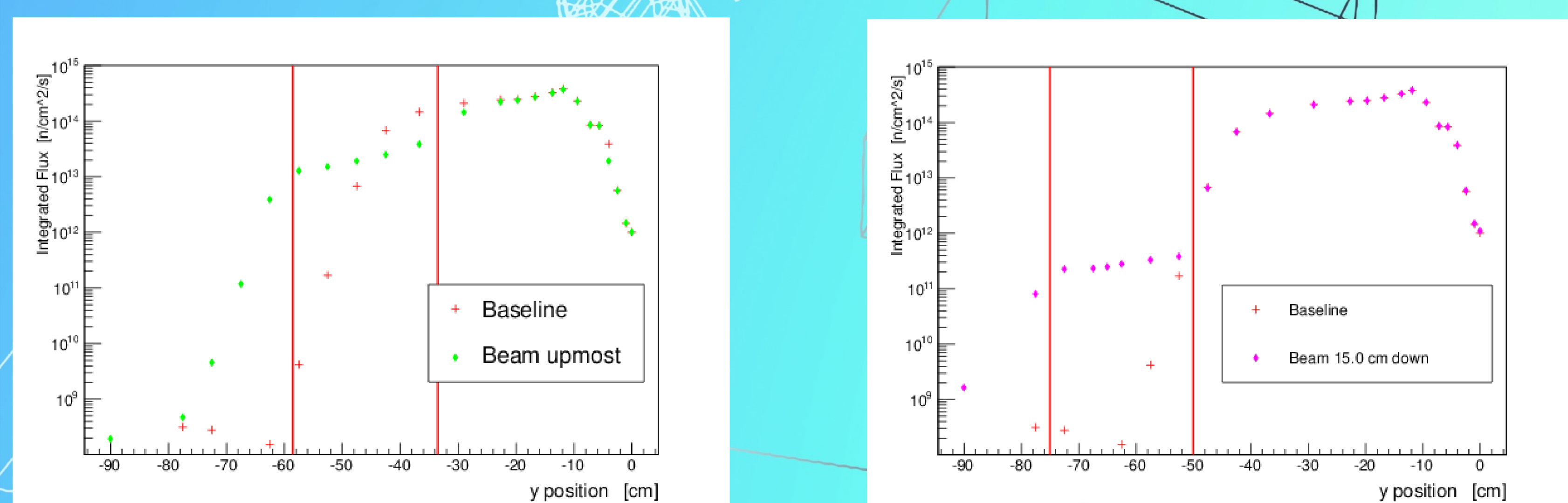


- Cold spectrum: **baseline** vs **beam-tube.**
- → Differences are minor.
  - Inserts show the difference (upper) and ratio (lower) between the two spectra

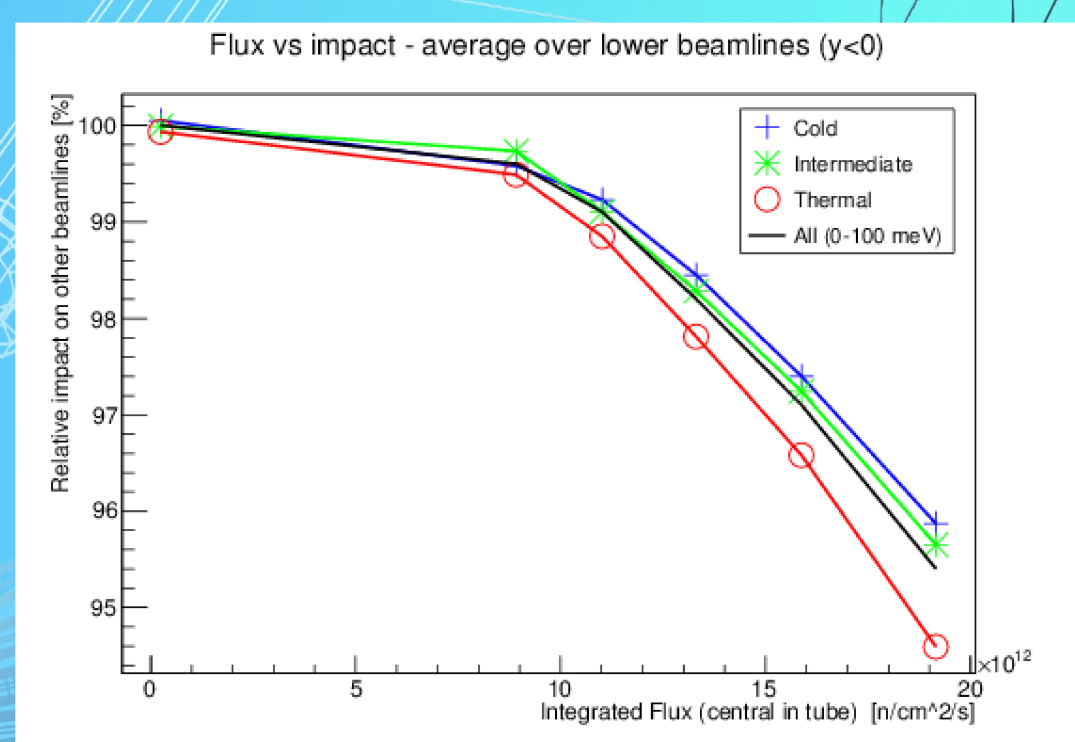


- Average cold/thermal (0-100meV) flux reduction (relative to baseline) in the lower beam-lines as a function of vertical position of the through-going tube.
- The upper beam-lines are unaffected.

Cold/thermal flux available for UCN moderator

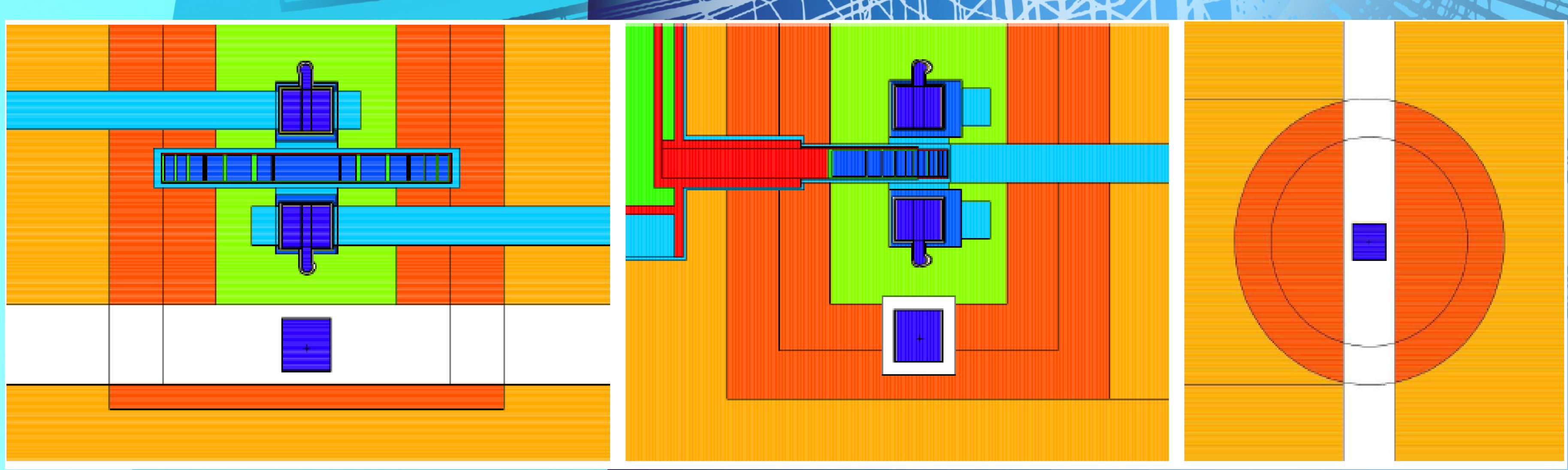


- Flux profile centrally under the lower cold para-H moderator



- Cold (0-5meV), Intermediate (5-20meV) and thermal (20-100meV) flux reduction (relative to baseline) in the lower beam-lines as a function of integrated cold/thermal flux available for UCN moderation
- The upper beam-lines are unaffected.

Heat-load



- To estimate heat-load a dummy para-H moderator (16cm x 16cm x 16cm) is placed centrally in the through-going tube.

y position [cm]	Flux [n/s/cm^2]	Heat-load [W/cm^3]
-47.5	2.4×10^{13}	0.20
-55.0	1.3×10^{13}	0.11
-62.5	2.9×10^{12}	0.06

Conclusions & prospects

- Depending on tube position, flux of up to 2×10^{13} n/s/cm^2 can be achieved (central in tube)
- Flux-impact on lower instruments ≤ 5% (0-100meV)
- Spectra at beam-ports (i.e. non-UCN instruments) ~unaltered
- The heat-load range: 0.06 – 0.20 W/cm^3 (measured in paraH)

Future:

- Test various moderator concepts, including cooling considerations
- Look into UCN time structure. Exploitable..?

[1] ESS Technical Design Report, April 23, 2013. ESS-doc-274,
[2] E. Klinkby et al, Proceedings of the Eleventh International Topical Meeting of Nuclear Applications of Accelerators (AccApp 13). In preperation